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SUPERSTARS AND THE LONG TAIL: THE IMPACT OF TECHNOLOGY ON MARKET STRUCTURE IN MEDIA INDUSTRIES

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ABSTRACT

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Technological change is transforming creative media industries. Digitisation lowers recording, storage, reproduction and distribution costs, while computer-based editing facilitates higher quality and special effects. With electronic distribution a vast range of content can be made available to consumers across global markets. The distribution of industry sales appears to be shifting: the late 20th century was the era of the 'hit parade' but attention has now shifted to the 'long tail'. This paper develops a model of differentiated products with endogenous quality and heterogeneous firms to examine the implications of technological change for product variety, quality, and the distribution of firms in media industries.

JEL Classification: L11, L15 and L82
Keywords: creative industries, digital media, long tail and superstars

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30 October 2011

Abstract

Technological change is transforming creative media industries. Digitization lowers recording, storage, reproduction and distribution costs, while computer-based editing facilitates higher quality and special effects. With electronic distribution a vast range of content can be made available to consumers across global markets. The distribution of industry sales appears to be shifting: the late 20th century was the era of the "hit parade" but attention has now shifted to the "long tail". This paper develops a model of differentiated products with endogenous quality and heterogeneous firms to examine the implications of technological change for product variety, quality, and the

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1 Introduction

Technological change is transforming creative media industries. In the production of recorded music and video content, digitization lowers the costs of recording, storage and reproduction. Computer-based editing makes higher-quality production possible at lower cost and facilitates new special effects. Distribution on physical media has shifted to more compact, higher quality formats—from vinyl and tape to CD for music; from VHS to DVD for video—while electronic distribution over cable and the internet greatly reduces distribution costs by eliminating the transportation of physical media. Digitization of television signals permits many more channels to be shown for a given capacity of radio spectrum or cable infrastructure, and allows images to be broadcast in higher definition. Online stores can stock a far wider range of products than local retail outlets, and online retailers have developed personalized search and recommendation services to assist consumers in finding content tailored to their individual tastes.

These developments are profoundly altering the structure of creative industries in this century, as earlier changes did in the last. The latter part of 20th century was the era of the "hit parade": the best artists became available to all via recorded and broadcast media (as compared with live performance), and consumer attention focused largely on a limited number of top movies, songs, and TV shows. The associated actors and artists became "superstars" and commanded high rents.[1] Now, in the early 21st century, the distribution within these industries appears to be shifting towards the

[1] See Rosen (1981) for an economic analysis of superstars and the skewness of returns in industries where talent of individual artists is important.

"long tail":[2] a higher proportion of demand is represented by products that achieve few sales individually but which collectively constitute a large part of the market.

These trends can be observed in the following industry statistics. In recorded music there are now fewer hit albums: in 2002 over a thousand albums achieved sales of 500,000 or more (i.e. gold, platinum, multi-platinum and diamond) but this fell by more than 40% to around 600 in 2005.[3] Meanwhile the top-selling albums achieve lower sales than they once did: in 2000, the top five albums combined sold 38 million copies; in 2005, the equivalent figure had almost halved to 19.7 million.[4] Alongside the decline in hit albums, there has been a growth in the long tail: bands and songs which used to be regarded as "misses" are increasingly important to industry producers and retailers. In other words, there has been a shift from hits to niches: demand is fragmenting into a multiplicity of sub-genres and across a wider set of bands.

In the movie industry, from the 1970s onwards the demand for movies was boosted by new, cheaper distribution channels: VHS and then DVD recording formats, subscription television,[5] and video on demand (VoD). This era saw the rise of the blockbuster movie, with huge expenditures on production and commensurate salaries to top artists (star actors, and sometimes producers/directors). The location of production also became more concentrated, with Hollywood dominating big-budget movie output and worldwide cinema audiences.[6] Now, as high-speed broadband connections become widely avail-

[2] As described by Anderson (2006).

[3] Figures from Anderson (2006), chapter 2.

[4] The music industry as a whole has suffered from the growth of piracy, especially unauthorized file-sharing via the internet, but hits have suffered disproportionately: for comparison, total sales in the music industry fell by a quarter between 2001 and 2005.

[5] In the US, restrictions on pay TV were abolished in the late 1970s, clearing the way for the growth of cable television.

[6] In Germany, France, and Italy the box office share of American movies rose from around 30% in the early 1970s to 50% or more in the mid 1990s. In 2001 the US accounted for 44% of world box office revenues. Figures from Waterman (2005), chapter 2.

able, videos may be purchased from online stores or downloaded over faster connections, reducing distribution costs and making a wider range of titles available to consumers. The limited evidence available[7] indicates both a growth in the long tail, with the number of titles generating just a few sales each week almost doubling, and the existence of a superstar effect: among the best-performing titles, a smaller number account for the bulk of sales.

Anderson (2006) highlights the role of internet distribution in causing the shift towards the long tail in recorded music.[8] However, it is unclear why this latest innovation in distribution method should have such an effect. The advent of recorded music in the 20th century—an invention that made the output of individual artists available to worldwide audiences—had the opposite effect, generating the superstar or "winner-take-all" phenomenon described by Rosen (1981) and Frank and Cook (1996). This suggests that a more subtle balance of cost and demand changes might be responsible. Meanwhile the emerging evidence from video distribution is more nuanced, with both long tail and superstar effects. It is also unclear how these trends will develop in the future: will the distributional shift from hits to the long tail continue or might it be mitigated by the strength of talented artists? With technological changes that increase the scope for raising product quality, what is the role of endogenous fixed costs[9] in this story? What is likely to happen to product variety, quality provision, and the superstar phenomenon?

This paper investigates the impact of technological change on creative media industries, in particular as it affects product variety, quality investment, product mix, and the size distribution of firms. To address these questions we build a model of the sector (which may be interpreted as music, movies, or television content) capturing its essential features: a large set of differentiated products; fixed costs which are often endogenous, increasing with

[7] See Elberse and Oberholzer-Gee (2007) for an analysis of US video sales

[8] Alternative, search-based explanations for the long tail phenomenon are examined by Brynjolfsson, Hu and Simester (2011), among others.

[9] As described by Sutton (1991).

quality; differences in the ability to deliver high quality products (or "talent"); and with the number and mix of products determined by free entry. To do this, existing spatial models of differentiated products are extended to capture quality investment and firm heterogeneity. The framework is used to analyse the impact of technological changes on industry outcomes, and to explore underlying mechanisms, e.g. the role of endogenous fixed costs. The aim of the research is twofold: to investigate which underlying developments can explain past industry trends, and to assess the likely impact of ongoing and potential future changes in technology.

The structure of the paper is as follows. Section 2 develops a model of differentiated products with endogenous quality and free entry, initially with homogeneous firms. This is extended to heterogeneous firms in section 3, where firms differ in their ability to deliver a high-quality product ("talent"). Using this framework, the impact of developments linked to digitization on industry structure and outcomes are examined. Section 4 concludes. An appendix contains longer proofs.

2 A model of differentiated products with endogenous quality

2.1 Modeling approach

In modeling creative media industries we wish to capture the following key features.[10]

- *Horizontal differentiation.* Media content is a highly diverse product class; consumers are heterogeneous in their individual preferences and most desire some variety of products.

[10] For detailed descriptions of the features and organization of creative industries and television broadcasting, see Caves (2000) and Caves (2005).

- *Fixed production costs.* Content production costs are almost entirely fixed: there is a large first copy cost but thereafter the marginal cost of supplying additional viewers is negligible. This cost function implies that price cannot equal marginal cost.

- *Quality and endogenous fixed costs.* While being fixed in relation to the number of consumers, production costs typically increase with higher quality; thus fixed costs are at least partially endogenous.

- *Distribution costs.* Retail distribution may incur some per-unit cost (e.g. pressing and delivering a CD or DVD), but this is small compared with the cost of content production. Internet distribution lowers this cost in a number of ways: by dispensing with the need for extensive retail floor space, more products can be stocked at lower cost; electronic distribution avoids the transportation costs of physical media; and consumer search costs may also be lower.

- *Talent of individual artists.* Artists are a key input into creative media content, be they actors, musicians, writers or directors. Artists have intrinsic talent, and more talented individuals are able to deliver higher quality products that less talented ones cannot. Differences in their attractiveness to consumers, and their earning power, can be huge.

Media industries are often modeled using a spatial model of product differentiation. The Hotelling (1929) model is used as the basis for modeling broadcasting competition by a number of authors (see, e.g., Anderson and Coate (2005), Armstrong and Weeds (2007), Peitz and Valletti (2008)). But whereas the Hotelling model takes the number of firms to be fixed (duopoly), for a market where the number of firms is determined by free entry the Salop (1979) model is more appropriate. A few authors have incorporated endogenous product quality in a Salop model of product differentiation, with a fixed cost that is increasing in quality (see Armstrong and Weeds (2007), Crampes, Haritchabalet and Jullien (2009), Repullo Conde (2006), and Seabright and Weeds (2007)).

In representing firms as competing for consumers around a circle, the Salop (1979) model is unhelpful in two respects, however. First, the model is a poor representation of reality in many differentiated product markets. It may be a reasonable approximation for spatial competition (say, between out-of-town stores located around a city), but is less appropriate for heterogeneous product classes such as media content where firms compete directly with all rivals, not just two nearest neighbors. Secondly, the model becomes intractable when firms are heterogeneous in anything other than locations: if, for example, firms have different costs, the symmetry of the model is forfeited and solutions become complex.[11]

To overcome the near-neighbor feature and allow for firm heterogeneity, we generalize the Salop model so that each firm competes directly with all others, not just its two nearest neighbors.[12] This section presents the basic model; heterogeneity in the ability to raise quality ("talent") is then added in section 3. The challenge is to find a model which is tractable under free entry, yielding a closed-form solution that permits further analysis. This model can then be used to examine the strategic choices of different firms and, with free entry of each type, the mix and market shares of talented and untalented producers in industry equilibrium.

In this model and that of section 3, model parameters capture the following four technological developments brought about by digitization:

- lower per-consumer distribution costs, due to digital recording formats, internet distribution and electronic downloads;
- lower (exogenous) fixed costs: e.g. cheaper recording equipment, edit-

[11] For a Salop-style model with heterogeneous firms see Vogel (2008).

[12] Salop-style models with symmetric competition have been developed by Von Ungern-Sternberg (1991) and Chen and Riordan (2007). These models, or similar functional forms, are used by Brito (2003), Armstrong and Wright (2009) and Germano (2008).

ing and storage;

- a lower cost of raising quality: e.g. improved processing of digital images, high definition, computer-based editing and special effects; and
- globalization: e.g. improved access to global markets, viewer familiarization, lower adaptation costs for digital formats.

The model in this section incorporates distribution and quality costs, and globalization (via the transport cost in a differentiated product setting). The model of section 3 extends this framework, allowing firms to differ in their ability to offer a high-quality product and their exogenous fixed costs.

2.2 The model

Each of $N \geq 2$ firms is connected to every other by a Hotelling line, the length of which corresponds to the mass of consumers between the pair. The total mass of consumers is normalised at 1 and demand is spread evenly between the lines, thus each pair of firms competes over mass $m = \frac{2}{N(N-1)}$. Unit transport cost is t. When firm i offers utility u_i to consumers, its market share is given by

$$s_i = \frac{1}{N} + \frac{(N-1)}{2t}\left(u_i - \overline{u}_{-i}\right) \tag{1}$$

where $\overline{u}_{-i} = \frac{1}{N-1}\sum_{j \neq i} u_j$.

Utility u_i from consuming product i depends on product quality v_i and price p_i as follows[13]

$$u_i = v_i - p_i. \tag{2}$$

A firm can choose its quality v_i by incurring a fixed cost $\frac{1}{2}\gamma v_i^2$. There is a marginal cost c of supplying each consumer.

[13] Advertising intensity and its disutility to consumers can readily be incorporated into model, but does not alter the conclusions (in effect, advertising revenue acts like a negative distribution cost). A version including advertising can be found in an earlier working paper available from the author.

Timing in the game is as follows. Firms first choose whether or not to enter the market; active firms and consumers locate as described above.[14] Firms then compete for consumers, simultaneously setting quality v and price p.

Firm i's profit is given by

$$\pi_i = \left(\frac{1}{N} + \frac{(N-1)}{2t} \left(u_i - \overline{u}_{-i} \right) \right) \left(p_i - c \right) - \frac{1}{2} \gamma v_i^2 .$$

Since $p_i = v_i - u_i$, we can write

$$\pi_i = \left(\frac{1}{N} + \frac{(N-1)}{2t} \left(u_i - \overline{u}_{-i} \right) \right) \left(v_i - u_i - c \right) - \frac{1}{2} \gamma v_i^2 \ .$$

Firm i's best responses in price and quality are

$$\begin{aligned} p_i &= \frac{t}{N(N-1)} + \frac{1}{2} \left(v_i + \overline{p}_{-i} - \overline{v}_{-i} + c \right); \\ v_i &= \frac{1}{2t\gamma} (N-1) (p_i - c) \end{aligned}$$

with $\overline{p}_{-i}$ and $\overline{v}_{-i}$ defined equivalently to $\overline{u}_{-i}$ above. With N firms, equilibrium price and quality are

$$p_N = \frac{2t}{N(N-1)} + c \quad \text{and } v_N = \frac{1}{\gamma N},$$

giving per-firm profit of

$$\pi_i = \frac{1}{N^2} \left(\frac{2t}{(N-1)} - \frac{1}{2\gamma} \right).$$

[14]The model structure implies that consumer locations are endogenous to the number of firms that enter. Such an assumption may be justified by the marketing experience that consumers have difficulty forming preferences over unknown products (or sets of characteristics), and instead form preferences over the available set of products.

With free entry, $\pi(N) = 0$ and the equilibrium number of firms is

$$N^* = 4t\gamma + 1, \tag{3}$$

and equilibrium price and quality are

$$p^* = \frac{1}{2\gamma\,(4t\gamma + 1)} + c \quad \text{and} \quad v^* = \frac{1}{\gamma\,(4t\gamma + 1)}. \tag{4}$$

It can be seen from these results that distribution cost c passes through in full to consumer prices, and has no effect on either the number of firms or quality investment.

2.3 Impact of digitization

In this model three parameters capture the effects of digitization: a lower distribution cost, c (digital formats, internet distribution); a lower cost of raising quality, γ (digital processing, high definition, computer-based editing and special effects); and a lower transport cost, t (viewer familiarization, lower adaptation costs), equivalent to market expansion or "globalization".[15] The following proposition presents the impacts of these changes on industry outcomes (proofs are straightward and are omitted).

Proposition 1 *In the endogenous quality model, the effects of changes brought about by digitization are as follows.*
(i) A lower distribution cost reduces equilibrium price, but has no effect on equilibrium quality or the equilibrium number of firms ($\frac{\partial p^*}{\partial c} > 0, \frac{\partial v^*}{\partial c} = \frac{\partial N^*}{\partial c} = 0$*).*
(ii) A lower quality cost raises equilibrium quality and price, and reduces the equilibrium number of firms ($\frac{\partial v^*}{\partial \gamma} < 0, \frac{\partial p^*}{\partial \gamma} < 0, \frac{\partial N^*}{\partial \gamma} > 0$*).*

[15] By increasing the accessibility of consumers in global markets, many of whom have similar tastes to domestic consumers, the dispersion of consumers is effectively reduced, captured in a locational model as a lower transport cost t.

(iii) A lower transport cost (globalization) raises equilibrium quality and price, and reduces the equilibrium number of firms ($\frac{\partial v^*}{\partial t} < 0, \frac{\partial p^*}{\partial t} < 0, \frac{\partial N^*}{\partial t} > 0$).

These results suggest that the role of digitization in lowering distribution costs has no effect on industry structure or quality investment, merely reducing consumer prices. By reducing the cost of raising quality, however, digitization has more wide-ranging effects, raising equilibrium quality and price while reducing the equilibrium number of firms. This is an endogenous fixed cost effect: as quality becomes cheaper to provide, firms invest more in raising quality and their fixed costs increase. With larger endogenous fixed costs, this reduces the equilibrium number of firms. In addition, prices must be higher to recoup the greater fixed costs. With a larger potential market, globalization (a lower transport cost t) raises the marginal return to quality, with similar effects to a lower quality cost. Firms invest more, raising equilibrium quality and price, while the larger endogenous fixed costs reduce entry. Both a lower quality cost and globalization generate a superstar effect: fewer firms offering higher quality and each capturing a larger proportion of the market.

3 Competition with heterogeneous firms

One of the motivations for this research is the question of how digitization affects relative outcomes for different artists or modes of production. Rosen's (1981) analysis of the economics of superstars derives the distribution of outputs and returns from underlying talent differentials and cost functions.[16] To capture this feature in the Salop framework we need to allow for heterogenous talent, where a talented type can raise its quality easily compared with

[16] Rosen finds that with lower recording costs, the shift from performance to recorded music increases the skewness of returns. Although there is greater entry by low-quality artists, returns to the highest talent—"superstars"—increase enormously.

a less talented one. This difference in productivity may be either intrinsic—a talented individual can generate a quality that is unattainable for lesser artists—or result from the chosen production method: e.g. studio production facilitates quality improvements that are not possible with home video recording.

Suppose there are two types of firm, untalented U and talented T. These may represent different forms of content provision, where a U-type represents low budget home video, such as that distributed on YouTube, while a T-type involves more expensive studio production, which allows greater scope for quality enhancement. Or they might represent alternative strategies chosen by *ex ante* identical firms, for example a broadcaster's choice between basic and premium content, where the quality of premium programming may be raised by additional investment.

An untalented firm pays a fixed cost $F > 0$ to supply a product of minimal quality v_0, normalised at zero,[17] and cannot raise quality further.[18] A talented firm has endogenous quality, producing a product of quality v at a total (exogenous + endogenous) fixed cost of $K + \frac{1}{2}\gamma v^2$. We assume that $K > F$: it seems a reasonable assumption that a higher-quality production requires larger exogenous fixed costs, e.g. studio recording facilities, more expensive equipment, and on-location filming. This assumption also ensures an equilibrium in which both types are present. For simplicity, we normalise the per-unit cost $c \equiv 0$; as demonstrated by the previous model, a per-unit cost simply adds to prices and affects no other variables.

Move order in the game is as follows. First, firms discover their types (or choose their production strategies); they then make entry decisions, before competing in prices p_U and p_T, and, for the talented type, quality v.

[17] Minimum quality v_0 is assumed sufficient to ensure full consumer participation.

[18] A related model with two types having differential quality costs that discover their type after entry finds that the higher-cost type makes no quality investment at all (for details see the earlier working paper available from the author). Hence the assumption that untalented types are unable to raise their quality is not unduly restrictive.

Firm i, of type $g \in \{T, U\}$, anticipates that a proportion λ of its rivals will be of type T and $(1-\lambda)$ of type U, with the total number of active firms being $N > 1$. Its market share is

$$s_g^i = \frac{1}{N} + \frac{(N-1)}{2t}\left(u_g^i - \lambda u_T^j - (1-\lambda) u_U^j\right)$$

where $u_T = v - p_T$, $u_U = -p_U$ and j denotes the choices of rival firms. Profit functions for the two types are

$$\begin{aligned} \pi_U^i &= s_U^i p_U^i - F; \\ \pi_T^i &= s_T^i p_T^i - K - \frac{1}{2}\gamma \left(v^i\right)^2. \end{aligned}$$

Each type's profit function is concave in its price and, for a T-type, in quality, thus second order conditions for a maximum are satisfied. First-order conditions determine equilibrium prices for each type and the T-type's equilibrium quality, given N and λ. Free entry conditions for each type ($\pi_U^i = 0$ and $\pi_T^i = 0$) then determine N and λ, yielding the following equilibrium outcomes[19]

$$p_U = FG; \tag{5}$$

$$p_T = KG > p_U; \tag{6}$$

$$v = 2(K-F)G; \tag{7}$$

$$N = 4t\gamma\frac{K-F}{K} + 1; \tag{8}$$

$$\lambda = \frac{F}{K-F}\left(\frac{KG}{4t\gamma(K-F)+K} - 1\right), \tag{9}$$

where $G = \sqrt{\frac{K}{2\gamma F(K-F)}} > 0$.

It can be seen that as $F \to 0$, $\lambda \to 0$ and talented types are crowded out. As $K \to F$, $\lambda \to \infty$ and untalented firms are crowded out. To ensure a

[19] Taking the positive root for λ.

solution such that $\lambda \in [0, 1]$ the following parameter restriction is required

$$\frac{4\gamma t (K - F) + K}{G} \in [F, K]. \quad (10)$$

Market shares for a single firm of each type are given by

$$s_U = \sqrt{2\gamma (K - F) \frac{F}{K}}; \quad (11)$$

$$s_T = \sqrt{2\gamma (K - F) \frac{K}{F}} > s_U. \quad (12)$$

The total market share of talented firms S_T is given by $\lambda N s_T$; naturally, the total share of untalented types $S_U = 1 - S_T$.

3.1 Impact of digitization

With heterogeneous firms, the following parameters capture the effects of digitization: a lower fixed cost for U-types, F; a lower fixed cost for T-types, K; a lower cost of raising quality for T-types, γ; and a lower transport cost t (globalization). Additionally we can consider the impact of a proportionate change in *both* fixed costs: to assess this, we rewrite these as $F \equiv \mu f$ and $K \equiv \mu k$, where $k > f$, and examine the effect of reducing μ. The following proposition presents the impacts of these changes on industry outcomes; the results are summarized in Table 1.

Proposition 2 *In the model with heterogeneous types, the effects of changes brought about by digitization are as follows.*
(1) A lower U-type fixed cost reduces U-types' equilibrium price, raises T-types' equilibrium quality, may increase or decrease T-types' equilibrium price, and raises the equilibrium number of firms. Subject to a necessary condition, the proportion of talented firms falls (a sufficient condition is $K < 2F$). The market share of a T-type firm increases while that of a U-type firm may decrease or increase, and the effect on the total market share of talented types

is ambiguous.
(2) A lower T-type fixed cost increases U-types' equilibrium price, reduces T-types' equilibrium quality, may increase or decrease T-types' equilibrium price, reduces the equilibrium number of firms, and increases the proportion of talented firms. The market share of an individual firm of either type falls, and the effect on the total market share of talented types is ambiguous.
(3) A proportionate fall in exogenous fixed costs for both types reduces equilibrium prices for both, reduces T-types' equilibrium quality, has no effect on the equilibrium number of firms but increases the proportion of talented firms. The market share of an individual firm of either type falls, but the total market share of talented types increases.
(4) A lower cost of raising quality for T-types increases equilibrium prices for both types, increases T-types' equilibrium quality, decreases the equilibrium number of firms, and increases the proportion of talented firms. The market share of an individual firm of either type falls but the total market share of talented types increases.
(5) A lower transport cost (globalization) has no effect on equilibrium prices or quality, reduces the equilibrium number of firms, and increases the proportion of talented firms. It has no effect on the market share of an individual firm of either type but increases the total market share of talented types.

Proof. The proposition follows from the comparative statics results (derivations are given in the appendix).
(1) $\frac{\partial p_U}{\partial F} > 0, \frac{\partial v}{\partial F} < 0, \frac{\partial p_T}{\partial F} < (>) 0$ for $F < (>) \frac{1}{2}K, \frac{\partial N}{\partial F} < 0, \frac{\partial \lambda}{\partial K} < 0$ for $4t\gamma > \frac{K(K-2F)}{(K-F)(4F-K)}, \frac{\partial s_T}{\partial F} < 0, \frac{\partial s_U}{\partial F} > (<) 0$ for $F < (>) \frac{1}{2}K$.
(2) $\frac{\partial p_U}{\partial K} < 0, \frac{\partial v}{\partial K} > 0, \frac{\partial p_T}{\partial K} < (>) 0$ for $K < (>) \frac{3}{2}F, \frac{\partial N}{\partial K} > 0, \frac{\partial \lambda}{\partial K} < 0, \frac{\partial s_T}{\partial K} > 0, \frac{\partial s_U}{\partial K} > 0$.
(3) $\frac{\partial p_U}{\partial \mu} > 0, \frac{\partial p_T}{\partial \mu} > 0, \frac{\partial v}{\partial \mu} > 0, \frac{\partial N}{\partial \mu} = 0, \frac{\partial \lambda}{\partial \mu} < 0, \frac{\partial s_T}{\partial \mu} > 0, \frac{\partial s_U}{\partial \mu} > 0, \frac{\partial S_T}{\partial \mu} < 0$.
(4) $\frac{\partial p_U}{\partial \gamma} < 0, \frac{\partial p_T}{\partial \gamma} < 0, \frac{\partial v}{\partial \gamma} < 0, \frac{\partial N}{\partial \gamma} > 0, \frac{\partial \lambda}{\partial \gamma} < 0, \frac{\partial s_T}{\partial \gamma} > 0, \frac{\partial s_U}{\partial \gamma} > 0, \frac{\partial S_T}{\partial \gamma} < 0$.
(5) $\frac{\partial p_U}{\partial t} = \frac{\partial p_T}{\partial t} = \frac{\partial v}{\partial t} = 0, \frac{\partial N}{\partial t} > 0, \frac{\partial \lambda}{\partial t} < 0, \frac{\partial s_T}{\partial t} = \frac{\partial s_U}{\partial t} = 0, \frac{\partial S_T}{\partial t} < 0$. ■

Table 1: Comparative statics in the model with heterogeneous firms

	N	λ	p_U	p_T	v	s_U	s_T	S_T
F	–	+(*)	+	– then +	–	+ then –	–	?
K	+	–	–	– then +	+	+	+	?
μ	none	–	+	+	+	+	+	–
γ	+	–	–	–	–	+	+	–
$\boldsymbol{t}$	+	–	none	none	none	none	none	–

* subject to necessary condition.

3.2 Discussion

The model allows us to examine the implications of three developments related to digitization: lower exogenous fixed costs (cheaper video hardware, storage and editing), cheaper/easier provision of quality (digital processing, high definition, computer-based editing and special effects), and market expansion due to globalization (viewer familiarization, lower adaptation costs), in a setting with heterogeneous firms. The effects of a change in one parameter are often quite complicated, with interactions between the variables; e.g. a change in exogenous fixed costs may alter quality investment (with no change in quality cost), affecting endogenous fixed costs and other industry outcomes.

Fixed costs

Recall that in Salop (1979) a reduction in (exogenous) fixed costs raises the equilibrium number of firms, increasing the number of varieties on offer to consumers. In our model, however, the relative incidence of fixed cost reductions for untalented and talented types makes a crucial difference to this result. If digitization reduces mainly the fixed costs of untalented types, F (e.g. by lowering the cost of home recording) then entry by untalented firms is encouraged, increasing the number of firms and raising variety (as in Salop), and generating a long tail. By contrast, if it is predominantly the fixed costs of talented types, K, that are reduced (e.g. lower costs of studio production) then the opposite result is found: the number of firms falls, reducing variety. This somewhat surprising result can be explained as follows. All else being equal, a reduction in fixed costs for talented firms stimulates entry by this type, increasing the proportion of T-type firms. But this leaves less room for untalented types, inhibiting their entry. Since the market share of each T-type exceeds that of a U-type (from (12)), entry of an additional talented firm squeezes out more than one untalented firm, reducing the total number of firms.

This is not the end of the story, however: changes in exogenous fixed costs also affect quality investment and endogenous fixed costs. By stimulating entry of T-types, a reduction in K induces each of the now-increased number of talented firms to invest less. This lowers their quality, decreasing the degree of vertical differentiation between T- and U-types. It also lowers the market share of an individual T-type firm; this explains why the impact on the total market share of talented firms is ambiguous. The opposite changes occur following a reduction in F: by encouraging entry of untalented firms, this inhibits entry of talented firms but increases investment by each one, raising their quality and increasing the degree of vertical differentiation. Thus long tail and superstar phenomena may coexist: there is a larger number of untalented types but talented ones invest more, delivering higher quality and increasing their individual market shares.

Cost of quality

As in Sutton (1991), endogenous fixed costs also play an important role in determining market structure. A reduction in the cost of quality stimulates investment by talented firms, increasing vertical differentiation. Endogenous fixed costs go up, reducing entry and hence the market provides less variety. The quality improvement by T-types squeezes the market share of untalented firms (who cannot raise quality). With a greater proportion of talented firms and more investment by each, the total market share of talented types increases. This is a superstar effect: the top artists invest larger amounts, offer higher quality, and take a larger share of the market.

Globalization

Globalization, modeled here as a lower transport cost, lowers the equilibrium number of firms and increases the proportion and total market share of talented firms, but has no effect on equilibrium prices or quality. As discussed in section 2.3, globalization raises the marginal return to quality, tending to stimulate investment: in the model of section 2, this effect increased quality and the greater endogenous fixed costs reduced entry, giving similar outcomes to a reduction in quality cost. Here, however, where product mix can change, rather than increasing quality globalization instead raises both the proportion and total market share of high-quality products. Increased entry of talented firms appears to offset the increased return to quality resulting from globalization, leaving quality unchanged. However, the high-quality products become more dominant—as Hollywood did in the global movie market of the late 20th century.

4 Concluding comments

We have developed a modeling framework which captures the key features of creative media industries: horizontally differentiated products, vertical differentiation through quality investment, and exogenous and endogenous fixed costs. This allows us to consider the impact of changes linked to digitization on market structure, product variety, and quality investment. By incorporating talent differences between firms, which may reflect either the intrinsic skill of artists or different production modes, we can also examine implications for product mix: the relative proportions of low- and high-quality types. These types may be variously interpreted as A- and B-movies, home video (such as that posted on YouTube) and studio production, basic and premium television content, or differing musical abilities. We have examined the implications of four developments brought about by digitization: lower distribution costs (due to digital recording formats, internet distribution and downloads), lower (exogenous) fixed costs (cheaper recording equipment, editing and storage), a lower cost of raising quality (processing of digital images, high definition, computer-based editing and special effects), and globalization (viewer familiarization, lower adaptation costs). Impacts on product variety, quality investment and vertical differentiation, and the mix of high- and low-quality types are assessed.

With a number of developments taking place simultaneously, interpreting recent trends and forecasting future ones is a challenge. The models developed in this paper suggest the following explanations. We find that lower distribution costs feed through to lower consumer prices: this trend has indeed been observed throughout the late 20th and early 21st centuries, as successive new formats make creative content available at lower prices.

The late 20th century was the era of the hit parade, characterized by high expenditure on the most talented individuals, and Hollywood dominance of the movie scene. This observation fits our results for a lower cost of quality—greater investment in and a larger share of the market taken by talented types—perhaps combined with globalization, which also increases the dominance of high-quality products. Thus technological changes in the late 20th century seem to have favoured talented individuals.

The early 21st century has witnessed the growth of the long tail in recorded music. This phenomenon could be explained by the reduction in fixed costs for untalented types: it is now cheaper to record, edit and set up distribution of music, with some new artists choosing to bypass the recording studios completely and launch themselves via the internet. In our model, this induces entry by low-quality types, which then account for a greater proportion of products, fitting the observed distribution. However, the model also suggests that talented types respond to this entry by investing more and increasing their individual market shares, a trend that has not really been seen in the music industry. It is possible that this effect has been inhibited by the problem of piracy, facilitated by digital recording and file-sharing, which has greatly undermined the music industry in the past decade. By contrast, based on the available evidence, the movie industry is currently experiencing both a growth in the long tail and increasing dominance of a small number of best-performing titles, an observation that conforms with the predicted distributional effect of lower fixed costs for untalented or basic content.

The multitude and complexity of technological developments in creative media industries make predictions for the future highly uncertain. Future trends will depend on the precise nature of changes brought about by new technologies: e.g. whether these affect exogenous or endogenous fixed costs, and which types of products are most affected. While developments in the late 20th century concerned mainly endogenous, quality-related fixed costs and globalization, benefiting the most talented creators, recent changes have improved the position of smaller artists. The impact of digitization in enabling small firms and individuals to produce and distribute their output at lower fixed cost can explain the recent, much-discussed long tail phenomenon. However, even if this trend continues, this does not necessarily mean that high-quality production is undermined: both lower fixed costs on their own, and in combination with other changes (in particular, lower costs of raising quality), can stimulate investment and strengthen the position of the most talented producers.

Appendix

Proof of Proposition 2.
(i) Number of firms, $N = 4t\gamma\frac{(K-F)}{K} + 1 = 4t\gamma\frac{(k-f)}{k} + 1$.
$\frac{dN}{dF} = -\frac{4\gamma t}{K} < 0$.
$\frac{dN}{dK} = 4\gamma t\frac{F}{K^2} > 0$.
$\frac{dN}{d\mu} = 0$.
$\frac{dN}{d\gamma} = 4t\frac{(K-F)}{K} > 0$.

$\frac{dN}{dt} = 4\gamma\frac{(K-F)}{K} > 0$.

(ii) Proportion of T-type firms, $\lambda = \frac{F}{(K-F)}\left(\frac{K}{(4t\gamma(K-F)+K)}\sqrt{\frac{K}{2\gamma(K-F)F}} - 1\right) = \frac{f}{(k-f)}\left(\frac{k}{(4t\gamma(k-f)+k)}\sqrt{\frac{k}{2\gamma\mu(k-f)f}} - 1\right)$.

$\frac{d\lambda}{dF} = \frac{KG}{(K-F)^2(4t\gamma(K-F)+K)}\left(\frac{4t\gamma\left(K^2-F^2\right)+K^2}{(4t\gamma(K-F)+K)} + \frac{(2F-K)}{2} - \frac{(4t\gamma(K-F)+K)}{G}\right)$ where $G = \sqrt{\frac{K}{2\gamma F(K-F)}}$. From (10) the lower bound on this expression is given when $\frac{4t\gamma(K-F)+K}{G} = K$. Thus $\frac{d\lambda}{dF} \geq \frac{KG((2F-K)K+4t\gamma(4F-K)(K-F))}{2(K-F)^2(4t\gamma(K-F)+K)^2}$. A necessary condition for $\frac{d\lambda}{dF} > 0$ is $4t\gamma > \frac{K(K-2F)}{(K-F)(4F-K)}$; a sufficient condition is $K < 2F$.

$\frac{d\lambda}{dK} = -\frac{FG}{(K-F)^2(4t\gamma(K-F)+K)}\left(\frac{4t\gamma\left(K^2-F^2\right)+K^2}{4t\gamma(K-F)+K} + \frac{F}{2} - \frac{4t\gamma(K-F)+K}{G}\right)$ where $G = \sqrt{\frac{K}{2\gamma F(K-F)}}$. From (10) the upper bound on this expression is given when $\frac{4t\gamma(K-F)+K}{G} = K$. Thus $\frac{d\lambda}{dK} \leq -\frac{F^2G(12t\gamma(K-F)+K)}{2(K-F)^2(4Kt\gamma-4Ft\gamma+K)^2} < 0$.

$\frac{d\lambda}{d\mu} = -\frac{K^2}{4\gamma\mu^2(K-F)^2(4t\gamma(K-F)+K)}\sqrt{\frac{2\mu\gamma F(K-F)}{K}} < 0$.

$\frac{d\lambda}{d\gamma} = -4t\frac{KF}{(4Kt\gamma-4Ft\gamma+K)^2}\sqrt{\frac{K}{2\gamma F(K-F)}} - \frac{1}{4\gamma^2}\frac{1}{(4Kt\gamma-4Ft\gamma+K)}\frac{K^2}{(K-F)^2}\sqrt{\frac{2\gamma F(K-F)}{K}} < 0$.

$\frac{d\lambda}{dt} = -4\gamma KF\frac{1}{(4Kt\gamma-4Ft\gamma+K)^2}\sqrt{\frac{K}{2\gamma F(K-F)}} < 0$.

(iii) Price of U-type firm, $p_U = \sqrt{\frac{FK}{2\gamma(K-F)}} = \sqrt{\frac{\mu fk}{2\gamma(k-f)}}$.

$\frac{dp_U}{dF} = \frac{K^2}{4\gamma(K-F)^2}\sqrt{\frac{2\gamma(K-F)}{FK}} > 0$.

$\frac{dp_U}{dK} = -\frac{F^2}{4\gamma(K-F)^2}\sqrt{\frac{2\gamma(K-F)}{FK}} < 0$.

$\frac{dp_U}{d\mu} = \frac{fk}{4\gamma(k-f)}\sqrt{\frac{2\gamma(k-f)}{\mu fk}} > 0$.

$\frac{dp_U}{d\gamma} = -\frac{KF}{4\gamma^2(K-F)}\sqrt{\frac{2\gamma(K-F)}{FK}} < 0$.

$\frac{dp_U}{dt} = 0$.

(iv) Price of T-type firm, $p_T = \sqrt{\frac{K^3}{2\gamma(K-F)F}} = \sqrt{\frac{\mu k^3}{2\gamma(k-f)f}}$.

$\frac{dp_T}{dF} = (2F-K)\frac{K^2}{4\gamma F^2(K-F)^2}\sqrt{\frac{2F\gamma(K-F)}{K}} < (>)0$ for $F < (>)\frac{1}{2}K$.

$\frac{dp_T}{dK} = (2K-3F)\frac{K^2}{4\gamma F(K-F)^2}\sqrt{\frac{2\gamma F(K-F)}{K}} < (>)0$ for $K < (>)\frac{3}{2}F$.

$\frac{dp_T}{d\mu} = \frac{k^3}{4\gamma f(k-f)}\sqrt{\frac{2\gamma f(k-f)}{\mu k^3}} > 0$.

$\frac{dp_T}{d\gamma} = -\frac{K^2}{4\gamma^2F(K-F)}\sqrt{\frac{2\gamma F(K-F)}{K}} < 0$.

$\frac{dp_T}{dt} = 0.$

(v) Quality of T-type firm, $v_T = \sqrt{\frac{2K(K-F)}{\gamma F}} = \sqrt{\frac{2\mu k(k-f)}{\gamma f}}.$

$\frac{dv_T}{dF} = -\frac{K^2}{2\gamma F^2}\sqrt{\frac{2\gamma F}{K(K-F)}} < 0.$

$\frac{dv_T}{dK} = \frac{(2K-F)}{2\gamma F}\sqrt{\frac{2\gamma F}{K(K-F)}} > 0.$

$\frac{dv_T}{d\mu} = \frac{k(k-f)}{2\gamma f}\sqrt{\frac{2\gamma f}{\mu k(k-f)}} > 0.$

$\frac{dv_T}{d\gamma} = -\frac{K(K-F)}{2\gamma^2 F}\sqrt{\frac{2\gamma F}{K(K-F)}} < 0.$

$\frac{dv_T}{dt} = 0.$

(vi) Market share for a U-type firm, $s_U = \sqrt{2\gamma\frac{F}{K}(K-F)} = \sqrt{2\gamma\mu\frac{f}{k}(k-f)}.$

$\frac{ds_U}{dF} = (K-2F)\sqrt{\frac{\gamma}{2KF(K-F)}} > (<)0$ for $F < (>)\frac{1}{2}K.$

$\frac{ds_U}{dK} = \frac{F}{K}\sqrt{\frac{F\gamma}{2K(K-F)}} > 0.$

$\frac{ds_U}{d\mu} = \frac{f\gamma(k-f)}{2k}\sqrt{\frac{2k}{\gamma\mu f(k-f)}} > 0.$

$\frac{ds_U}{d\gamma} = \sqrt{\frac{F(K-F)}{2\gamma K}} > 0.$

$\frac{ds_U}{dt} = 0.$

(vii) Market share for a T-type firm, $s_T = \sqrt{2\gamma\frac{K}{F}(K-F)} = \sqrt{2\gamma\mu\frac{k}{f}(k-f)}.$

$\frac{ds_T}{dF} = -\frac{K}{F}\sqrt{\frac{\gamma K}{2F(K-F)}} < 0.$

$\frac{ds_T}{dK} = (2K-F)\sqrt{\frac{\gamma}{2FK(K-F)}} > 0.$

$\frac{ds_T}{d\mu} = \frac{\gamma k(k-f)}{2f}\sqrt{\frac{2f}{(k^2\gamma\mu - fk\gamma\mu)}} > 0.$

$\frac{ds_T}{d\gamma} = \sqrt{\frac{K(K-F)}{2F\gamma}} > 0.$

$\frac{ds_T}{dt} = 0.$

(viii) Total share of T-types, $S_T = \frac{K}{(K-F)} - (4\gamma t(K-F)+K)\sqrt{\frac{2\gamma F}{K(K-F)}} = \frac{k}{(k-f)} - (4\gamma t(k-f)+k)\sqrt{\frac{\mu 2\gamma f}{k(k-f)}}.$

$\frac{dS_T}{dF} = \frac{K}{(K-F)^2} + \left(\frac{2t\gamma}{K}(2F-K) - \frac{K}{2(K-F)}\right)\sqrt{\frac{2\gamma K}{F(K-F)}}.$

$\frac{dS_T}{dK} = (4t\gamma(K-F)+K)\frac{\gamma F(2K-F)}{2K^2(K-F)^2}\sqrt{\frac{2K(K-F)}{F\gamma}} - \frac{F}{(K-F)^2} - (4t\gamma+1)\sqrt{\frac{2\gamma F}{K(K-F)}}.$

The signs of $\frac{dS_T}{dF}$ and $\frac{dS_T}{dK}$ are ambiguous.

$\frac{dS_T}{d\mu} = -(4t\gamma(k-f)+k)\frac{\gamma f}{2k(k-f)}\sqrt{2\frac{k^2-fk}{\mu f\gamma}} < 0.$

$$\frac{dS_T}{d\gamma} = -4t\sqrt{\frac{2\gamma F(K-F)}{K}} - \sqrt{\frac{F}{2\gamma K(K-F)}}\left(4t\gamma\left(K-F\right)+K\right) < 0.$$
$$\frac{dS_T}{dt} = -4\gamma\left(K-F\right)\sqrt{\frac{2\gamma F}{K(K-F)}} < 0.$$

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